ployed, are men of education. The managers and heads of departments, often those who are analogous to what we should call foremen in England, have a university education. All have spent many more years on their education than is usual in England."

In an address on "The Ethics of Chemical Manufacture," Dr. Brown would have the manufacturer remember that he has other and higher privileges, and that nobler duties devolve upon him than those which necessarily occupy the greater part of his thoughts during business hours. The satisfactory thing to contemplate in the development of the alkali industry is not the fortunes it made, nor even the employment it gave to thousands, but that it gave cheap and abundant means of cleansing self, raiment and dwelling to every family among the civilized nations of the earth. Balard is revered now not because he manufactured so many thousand kilos per week of salt from the sea water, but because, experimenting one day with the mother liquor, he observed for the first time some reddish-brown vapors, and followed them up, and became the discoverer of bromin. "Joule doubtless made excellent beer, because he is the sort of man who does everything well he undertakes; but his great work for which the world is indebted to him, and by which he will be remembered with gratitude throughout all time, was his determination of the mechanical equivalent of heat, whereby he laid the foundation of chemical dynamics and of the science of thermal chemistry, as well as brought about a revolution in an important branch of physics." The coal-tar dyestuff industry is not looked upon with much favor by Dr. Brown. "When one sees the glaring colors which are now flaunted before the public eye, often without any thought of harmony and with no consideration of appropriateness of position and surroundings —in advertising placards, house decoration, dress and so forth—one is sometimes tempted to ask whether the production of these new dyes has been a good thing for mankind, and whether, when our last mines are worked out and coal-tar dyes cease to be manufactured, the world will be any better for having had them, and whether the huge industry, which is at present flourishing, is not a waste of time, and of carbon compounds that would be better saved to keep us warm in winter—whether, at least, its highest merit is not that it affords a present means of livelihood to so many thousand workmen." The knowledge gained from the study of coal-tar products is the real justification of the "waste"; "this, rather than cheap alizarin, gaudy bills, brilliant shop windows and rainbow-colored dress, is the thing of which the coal-tar manufacturer should be proud."

A most interesting chapter is the address, "Reminiscences of August Wilhelm von Hofmann." Dr. Brown was a student in Hofmann's laboratory in the school of mines, and the story of the great master in lecture room and laboratory is most entertainingly told, with delightful personal touches. Here also we find most favorable views of German industry as he speaks of Hofmann's students and assistants working from nine in the morning till six at night, and often returning after dinner to work privately till a late hour. "That is the kind of work which tells. An eight-hours day may be all very well for working men who have no ambition and who are content with daily bread (and beer); but a gentleman has to work much harder."

There is included in the volume Dr. Brown's translation of the autobiographical fragment of Liebig, which originally appeared in the *Deutsche Rundschau* for January, 1891, and which is of great interest; and also a single original investigation, "Aquiculture: a Study of Deposits in Pipes and Other Channels Conveying Potable Water," read before the Institution of Civil Engineers. Altogether, the book as a whole is well worth perusal, both by chemists and by the general public.

J. L. H.

SCIENTIFIC JOURNALS AND ARTICLES

The July number (Vol. 16, No. 3) of the *Transactions of the American Mathematical Society* contains the following papers:

M. Fréchet: "Sur les fonctionnelles bilinéaires."

D. F. Barrow: "Oriented circles in space."

D. Buchanan: "A new isosceles triangle solution of the three-body problem."

L. P. Eisenhart: "Surfaces Ω and their transformations."

E. J. Wilczynski: "The general theory of congruences."

J. H. M. Wedderburn: "On matrices whose coefficients are functions of a single variable."

E. Kasner: "Conformal classification of analytic arcs or elements: Poincaré's local problem of conformal geometry."

D. R. Curtiss: "Extensions of Descartes' rule of signs connected with a problem suggested by Laguerre."

J. B. Shaw: "On parastrophic algebras."

THE concluding (July) number of Vol. 21 of the *Bulletin of the American Mathematical Society* contains: Report of the April meeting of the society in New York, by F. N. Cole; "An elementary double inequality for the roots of an algebraic equation having greatest absolute value," by G. D. Birkhoff; "Certain non-enumerable sets of infinite permutations," by A. B. Frizell; "George William Hill, 1838–1914," by E. W. Brown; Review of Dickson's Linear Algebras, by W. C. Graustein; "Shorter Notices": Poincaré's Wissenschaft und Methode, by J. B. Shaw; Martin's Text-book of Mechanics, Vol. 5, by F. L. Griffin; "Notes"; "New Publications"; Twenty-fourth Annual List of Published Papers; Index of Volume 21.

SPECIAL ARTICLES

THE THEORY OF MAGNETIZATION BY ROTATION

THE experiment which I described in a recent number of this journal may be considered as a modification of an experiment made long ago by Maxwell,[1] who appears to have been the first to conceive the idea that a magnet should behave like a gyrostat if its Ampèreian currents are actually *material,* as modern theory assumes. In Maxwell's experiment an electromagnet, mounted in a frame in such a way as to be free to move about a horizontal line through its center of mass and perpendicular to its magnetic axis, was rotated at high speed about a vertical line, and optical observations were made to see whether the angle α between the vertical and the magnetic axis was altered as the speed increased from zero, stability being secured by properly adjusting the moments of inertia. No change in α was observed, but only rough experiments were possible.

In my experiment the electromagnet is replaced by each of the countless multitude of molecular magnets of which the iron rod is constituted, and the total change in the orientation of all the magnets with reference to the axis of rotation of the rod is determined magnetically instead of optically.

In the complete paper it is shown that the angular momentum M of the simplest type of molecular magnet possible, constituted of a negative electron with mass m and charge e revolving with angular velocity ω in a circular orbit about a positive nucleus with charge $-e$ at rest, is related to the magnetic moment μ by the equation

$$M = 2(m/e)\mu. \qquad (1)$$

If now the rod of which the molecular magnet is a part is set into rotation about its axis AB, with angular velocity Ω, the angle α between the vector M and AB will *decrease,* just as in the case of a gyroscope, until the torque T' on the system brought into existence by this displacement is just equal to the rate of increase of its total angular momentum in the steady state when kinetic equilibrium has been reached and the vector M is tracing out a conical surface with constant semi-angle α and angular velocity Ω. The effect in this steady state is exactly the same as if the rod were at rest and the molecular magnet were acted upon by a torque $T'' = -T'$ due to an extraneous magnetic field of strength H, where H is the intrinsic magnetic intensity of rotation. The complete expression for the torque T'' is known (and can readily be shown from first principles) to be

$$T'' = -T' = -M\Omega \sin \alpha - B\Omega^2 \sin \alpha \cos \alpha, \qquad (2)$$

where B denotes the difference between the

[1] *Elec. and Mag.*, § 575.